International Study of Risk-Mitigating Factors and In-Flight Allergic Reactions to Peanut and Tree Nut

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What is already known about this topic? This is the fourth study to investigate passenger reports of in-flight reactions to peanut and tree nut. This report, like the other reports, notes that severe reactions are reported and that epinephrine continues to be underused as treatment for reactions.

What does this article add to our knowledge? This is the first study to show that in-flight peanut and tree nut allergy is an international problem. Passenger nationality differentially affects what preflight notifications or in-flight preparations at-risk passengers will make, but does not affect the odds of using epinephrine to treat a reaction.

How does this study impact current management guidelines? This is the first study to show that certain passenger-initiated risk-mitigating behaviors may reduce the odds of experiencing a reaction in flight, which may be of assistance to clinicians wishing to advise concerned patients to take these steps when flying commercially.

BACKGROUND: Three studies have analyzed in-flight peanut/tree nut reactions, although the studies were conducted exclusively among Americans.

OBJECTIVE: We studied the international in-flight experience and determined the efficacy of certain risk-mitigation strategies.

METHODS: A 47-question on-line survey was distributed through the websites and social media outlets of the member organizations of the Food Allergy & Anaphylaxis Alliance. Both persons reporting an in-flight reaction and nonreactors were surveyed to assess details of air travel preparation and any reported reaction. Data were analyzed to determine the association among flying behaviors, reported reactions, and nationality.

RESULTS: We found that 349 reactions were reported among 3273 respondents from 11 countries; 13.3% received epinephrine as treatment. Flight crews were notified about 50.1% of reactions. Sixty-nine percent of all respondents reported making a preflight accommodation request, although just 55% of reactors did so compared with 71.6% of nonreactors ($P < .001$). Adjusted odds of epinephrine use were increased with reported gastrointestinal or cardiovascular symptoms or with notifying the crew. Passengers who requested any accommodation, requested a peanut/tree nut–free meal, wiped their tray table, avoided airline pillows or blankets, requested a buffer zone, requested other passengers not consume peanut/tree nut–containing products, or reported not consuming airline-provided food had significantly lower adjusted odds of reporting a reaction.

CONCLUSIONS: In-flight peanut and tree nut reactions occur internationally. Epinephrine was sparsely used to treat reactions. We identified 8 risk-mitigating behaviors associated with lower odds of a reported reaction. Future study is necessary to further validate the effectiveness of these passenger-initiated risk-mitigating behaviors. **(J Allergy Clin Immunol: In Practice 2013;1:186-94)**

Key words: *Anaphylaxis; Epinephrine; In-flight allergy; Peanut allergy; Tree nut allergy*

Peanut and tree nut allergy affects 1% to 2% of persons in Westernized countries.[1] These reactions can become progressively severe, are often associated with anaphylaxis, and unintended exposure, which contributes to anxiety and a poor quality of life among allergic families.[1-6] The issue of safe air travel among such families is potentially anxiety provoking, given that many commercial air carriers serve peanut and/or tree nut–containing food during the flight, leading to concerns about the possibility of an in-flight reaction. Three prior US studies have described in-flight peanut allergy and have identified reports

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Abbreviations used
FAAA- Food Allergy & Anaphylaxis Alliance
FAI- Food allergic individual

of reactions attributable to inhaling peanut dust, reactions resulting in anaphylaxis, and that few passengers report receiving epinephrine as treatment despite it being available.[7-9] However, it is still a matter of controversy as to whether dust from peanut and tree nuts can aerosolize and induce a reaction, or if vapors from peanut or nut butter can as well.[10,11]

Airline policy on handling in-flight reactions to peanut and tree nut allergies has been inconsistent between different carriers and nations. The decision in the United States on how to manage such passengers is generally the purview of the particular airline.[12] However, in other countries this may not be the case. The Canadian Transportation Agency has taken action to protect passengers with allergy in response to consumer complaints and has directed Air Canada (but not other Canadian carriers) to create a buffer zone, on advance request, around which peanut or nut products cannot be consumed.[13] In the United States, pre-existing legislation prevents government-sponsored study of this issue until scientific evidence proves that a circulating allergen poses a risk to passengers with allergy.[12,14] In the absence of formal policy, solutions that have been used by airlines include a voluntary ban on distributing packaged peanuts, overhead announcements that request passengers not consume peanut/tree nut products on that flight, creating peanut-free buffer zones, and passenger preboarding.[15-17] However, the efficacy of these measures has not been studied previously.

Internationally, food allergy advocacy groups frequently receive passenger reports of reaction to a peanut/tree nut or difficulties in protecting a traveler with allergy while flying (personal communication, Christopher Weiss and Terrence Furlong, formerly with The Food Allergy & Anaphylaxis Network). However, no international study on this subject exists, and the global scope of this issue is unknown. Moreover, prior studies of this subject have been limited to the experience of the person who experiences a reaction. No data are available about the flying behaviors of travelers with peanut/tree nut allergy who do not react. Therefore, the aims of this study were to characterize the global experience of persons with peanut and tree nut allergy who report in-flight allergic reactions and to compare preflight and in-flight behavior between persons reporting and not reporting a reaction to determine whether any risk-mitigating behaviors may be associated with safer flying. Such behaviors could inform airline and government policy and could serve as useful information for future passengers.

METHODS

A 47-question, on-line survey was administered to members, website visitors, and social media followers of parent advocacy groups belonging to the Food Allergy & Anaphylaxis Alliance (FAAA), using Survey Monkey (Portland, Ore). The survey was conducted between January and July 2011. FAAA comprises food allergy advocacy groups from 12 countries in North America, Europe, Asia, Australia, New Zealand, and the Middle East, with a collective mission to unite organizations working in food allergy and anaphylaxis to exchange information, form partnerships, and advance key issues of importance to those with food allergy and anaphylaxis.[18] The survey was freely available to persons 18 years of age or older, irrespective of membership status, as a web-link on participating member country websites and social media pages. Parents of children with food allergies were asked to take the survey as a surrogate for their child.

Questions were designed to screen out persons with non-peanut or tree nut allergy, and multiple responses per question were allowed for selected items. Not all items were required to be completed, and skip logic was used to direct participants around nonrelevant sections. Questions were similar in overall theme to a recent 2008 study.[9] Items queried specific air travel behaviors, focusing on preparation and notification strategies of both persons reporting an in-flight reaction and persons who did not, as well as focusing on details of one's single most severe in-flight reaction, including medication use, symptoms that developed, and changes in subsequent air travel behavior as a result of an in-flight reaction. The nationality of the specific air carrier was asked, although no items inquired about specific country of departure. All questions were written and posted in English, per collective decision of the membership of the FAAA. No identifiable information was collected. Electronic informed consent was obtained from all participants. This study was approved by the University of Michigan Medical School Institutional Review Board.

Data were analyzed for descriptive statistics to characterize the study population. Bivariate associations were investigated with chi-square/Fisher exact testing and logistic regression. Adjusted multiple logistic regression with a prespecified set of predictors (age, sex, nationality, prior reaction, organ system symptoms, making a request for accommodation or using a risk-mitigating behavior, allergen type, epinephrine autoinjector availability, and reactor status) were used to determine a model of behaviors associated with odds of reporting an in-flight reaction or using epinephrine to treat a reaction. An α level of 0.05 was used to determine significance of all tests. Analysis was performed with Stata IC, version 12 (College Station, Tex). No research funding for this study was provided by any member organization of the FAAA, and all data analysis was performed by the University of Michigan.

RESULTS

A total of 3601 persons accessed the survey, with 3273 persons completing the survey (90.8%). Responses were collected from persons in 11 countries: the United States, Canada, England, Germany, Australia, New Zealand, Hong Kong, Italy, India, the Netherlands, and Spain. Respondents were primarily parents of persons with food allergy (n = 2610; 79.7%). The reported ages of persons with food allergy ranged from 3 months to >50 years old. Among the total responding population, 60.7% reported an allergy to both peanut and at least 1 tree nut, 28.9% to peanut alone, and 10.3% to tree nut alone. Only 13.3% (n = 435) reported that they were sensitized to one of these items without having experienced a reaction. Significantly more Americans than non-Americans reported not flying again after receiving a diagnosis of peanut/tree nut allergy (60.4% vs 39.5%; $P < .001$). An in-flight peanut/tree nut reaction was reported by 349 (10.7%) of the total respondents. Reactions were reported among passengers hailing from 9 of the 11 aforementioned countries (no reported reactions from respondents from Spain or India), occurring on 40 separate airlines. Further characteristics of the population, stratified by reactor versus nonreactor, are detailed in Table I.

TABLE I. Characteristics of survey respondents

Characteristic	No. (%)	Nonreactors (%) (n = 2361)	Reactors (%) (n = 346)	*P* value
Sex (n = 3222)				<.001
Male	1707 (47)	46.8	43	
Female	1515 (53)	53.2	57	
Age (n = 3225)				<.001*
Younger than 12 y	2155 (66.8)	66.3	46.4	
12-18 y	478 (14.8)	16.2	13.3	
>19 y	592 (18.4)	17.5	40.3	
Nationality (n = 2237)				<.001*
United States	999 (44.7)	42.1	59.5	
Canada	674 (30.1)	10.4	21	
Australia	217 (9.7)	31.7	5.8	
United Kingdom	183 (8.2)	0.3	7	
Netherlands	66 (2.9)	3	2.4	
New Zealand	55 (2.4)	2.5	2.4	
Other	29 (1.3)	8.4	1.3	
Spain	6 (0.3)	1.3	NA	
Germany	4 (0.2)	0.2	0.3	
Hong Kong	4 (0.2)	0.2	NA	
Had personal epinephrine source (n = 2663)	2584 (97)	98.2	88.9	<.001
Requested any accommodation (n = 2733)	1898 (69.4)	71.6	55.0	<.001
Request PN/TN snacks not be distributed	1327 (48.5)	49.2	42.8	
Announcement to not eat items with PN/TN	919 (33.6)	34.5	27.8	.01
Request special PN/TN-free meal	887 (32.5)	34.6	18.0	<.001
Buffer zone	810 (29.6)	30.5	24.1	.02
Pre-board	763 (27.9)	28.3	25.5	
Request to sit in certain seat/zone	332 (12.1)	12.6	9.2	
Perform any risk-mitigating behavior (n = 2733)	2349 (85.9)	89.9	59.0	<.001
Bring own food	2274 (83.2)	87.1	56.4	<.001
Wipe tray table	1677 (61.4)	63.0	50.1	<.001
Wipe arm rest	1519 (55.6)	56.7	47.8	.002
Avoid using airline pillow	1323 (48.4)	48.7	46.4	
Avoid using airline-provided blanket	1294 (47.3)	47.6	45.6	
Wipe seat back	1293 (47.3)	48.0	42.4	.05
Wipe seat belt	1277 (46.7)	47.3	43.0	
Wipe surfaces (eg, bathroom door handle)	651 (23.8)	23.9	22.9	

PN/TN, Peanut/tree nut.
*Value for non-2 × 2 chi-square that at least 1 of the cells had a significant difference between the observed and expected counts.

Ninety-five reactions reported on internationally registered carriers; 190 on US registered carriers; 26 reactions on a carrier not included in the survey list of 70 airlines; thus, the nationality of the carrier could not be specified; and 38 reactions in which the respondent did not provide a response to this question. American and Canadian (North American) passengers accounted for 75.6% of all reported reactions (n = 264). One single US carrier was associated with 63 reported reactions (18.1%). Among those reporting a reaction, 314 (90%) were aware of their allergy before the in-flight reaction occurred. Peanut was the attributed cause in 69.5% of the reactions (n = 239), and 92.8% (n = 304/328) of the reactions were reported by passengers sitting in coach class. The crew was notified of the in-flight reaction in only 50.1% of cases. Only 27 of 349 reaction (7.8%) were reportedly untreated. Epinephrine was used to treat 46 reported reactions (13.3%). Among epinephrine recipients, 18 of 46 (39.1%) reported receiving this at the development of the first symptom, and 41 of 46 doses (91%) were reportedly administered within 15 minutes of symptom development. Multiple epinephrine doses were used in 13 of 46 reaction (29%). Of the 46 cases receiving epinephrine, 41 recipients (91%) reported administering their own supply of epinephrine they had brought on board. Characteristics of passengers who reported a reaction are detailed in Table II. On-board medical assistance from another passenger who was a physician was requested for 24 reactions (6.9%), and the flight was diverted in 11 cases (3.2%). Table III details a logistic regression model that compares the relation between symptom presentation and passenger characteristics that influenced the reported use of epinephrine to treat the reaction. The proportion of reactors who reported making flying behavior changes as a result of the reaction is detailed in Figure 1.

We also examined reported accommodation requests and personal risk-mitigating behaviors among passengers who did not react (nonreactors). Comparison of reactor with nonreactor requests for accommodation, personal risk-mitigating behaviors

TABLE II. Age-stratified characteristics of passengers reporting an in-flight reaction

Characteristic (n = 347 passengers reacting)	No. (%)	Younger than 12 y (%) (n = 161)	12-18 y (%) (n = 46)	Older than 19 y (%) (n = 140)	*P* value*
Aware of allergy before flight	314 (90.5)	45.9	14	40.1	
Time of reaction					<.001
Within past year	80 (23.1)	56.3	11.2	32.5	
1-2 y ago	77 (22.2)	58.4	7.8	33.8	
3-4 y ago	82 (23.6)	54.9	11	34.1	
>5 y ago	108 (31.1)	23.6	19.8	56.6	
Cause (n = 345)					<.001
Peanut	239 (69.5)	50.2	12.6	37.2	
Tree nut	57 (16.4)	28.1	17.5	54.4	
Unsure if peanut or tree nut	49 (14.2)	48.9	10.2	40.8	
Exposure route (n = 345)					<.001
Ingestion	45 (13.0)	17.8	11.1	71.1	
Inhalation	155 (44.7)	37.4	15.5	47.1	
Contact	114 (32.9)	63.1	12.3	24.6	
Unsure	31 (8.9)	71	6.4	22.6	
Prior in-flight reaction (n = 335)	140 (41.8)	37.9	10	52.1	<.001
Treatment received					
Epinephrine	46 (13.3)	34.8	10.9	54.3	.039
H1-antihistamine	297 (85.6)	48.5	14.1	37.4	
Albuterol	130 (37.5)	41.5	16.2	42.3	
Steroid	61 (17.6)	37.7	19.7	42.6	.025
Untreated	27 (7.8)	37	3.7	59.3	
Crew notified of reaction	174 (50.1)	44.8	16.7	38.5	
Made request/performed risk-mitigating behavior	217 (62.5)	57.1	12.4	30.4	<.001
Skin symptoms developed	290 (83.6)	49.7	12.7	37.6	.021
GI symptoms developed	84 (24.2)	35.7	11.9	52.4	.032
Respiratory symptoms developed	287 (82.7)	45.1	12.6	42.2	
Cardiovascular symptoms developed	77 (22.2)	26	11.7	62.3	<.001

GI, Gastrointestinal.
*Value for chi-square test to assess the age strata that at least 1 of the cells had a significant difference between the observed and expected counts.

taken, and rates of carrying a personal source of epinephrine are displayed in Table I. It is notable that significantly fewer reactors had a personal source of epinephrine, made a specific request of the airline, or performed a personal risk-mitigating behavior. Tables IV and V detail a multiple logistic regression analysis that compares the adjusted association of specific preflight/in-flight behaviors and requests with the odds of reporting an in-flight peanut or tree nut reaction. Persons who reported a reaction had significantly lower odds of performing the following 8 risk-mitigating behaviors: (1) making any request of the airline, (2) requesting a buffer zone, (3) requesting an announcement that passengers not eat peanut/tree nut—containing goods, (4) requesting a peanut/tree nut—free meal, (5) wiping their tray table, (6) bringing their own food from home, and (7) avoiding use of an airline-provided pillow, and (8) avoiding use of an airline-provided blanket.

Notable international differences were observed in the odds of performing risk-mitigating behaviors, also detailed in Tables IV and V. Compared with US passengers, European, Asian/Pacific, Canadian, and other nationalities had significantly lower odds of wiping their tray tables or any aspect of their personal seating area, avoiding the use of airline-provided blankets/pillows, or requesting to pre-board. European and Asian/Pacific passengers had significantly lower odds of wiping common potentially contaminated surfaces or bringing their

TABLE III. Logistic regression model for factors associated with the use of epinephrine to treat an in-flight allergic reaction among passengers reporting an event

Predictors of epinephrine use to treat reaction	OR (95% CI)	*P* value
Nationality		
United States (reference)	1.00	
Canada	0.95 (0.33-2.75)	.931
Europe	1.29 (0.38-4.39)	.689
Asia/Australia/New Zealand	0.46 (0.07-2.87)	.407
Age		
Younger than 12 y (reference)	1.00	
12-18 y	0.41 (0.1-1.64)	.207
Older than 19 y	0.99 (0.36-2.72)	.985
Cutaneous symptoms reported	0.73 (0.14-3.86)	.709
Cardiovascular symptoms reported	2.92 (1.23-6.92)	.015
Gastrointestinal symptoms reported	2.54 (1.08-5.97)	.033
Pharyngeal/laryngeal symptoms reported	2.46 (0.64-9.43)	.188
Cough or wheeze reported	1.66 (0.66-4.13)	.279
Airline had peanut/tree nut restriction policy	0.33 (0.1-1.09)	.069
Crew notified of the reaction	4.57 (1.56-13.4)	.006
Made request or performed risk-modifying behavior	1.43 (0.5-4.07)	.5
Had personal epinephrine source available	0.69 (0.14-3.43)	.653

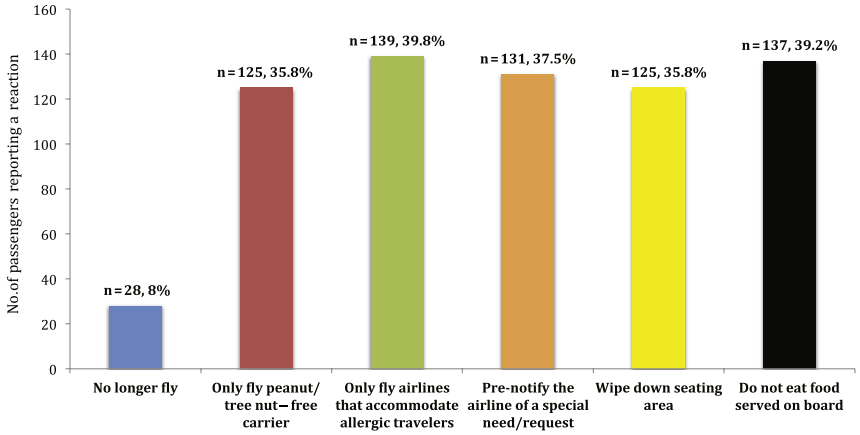

FIGURE 1. Changes in flying behaviors as a direct result of experiencing an in-flight reaction among the 349 respondents reporting a reaction. Multiple responses were allowed.

own food to consume on flights. Canadian and European passengers had significantly higher odds of requesting an announcement that other passengers not consume nut–containing products than US passengers. Asian/Pacific passengers had lower odds of making this request, as well as lower odds of requesting that the airline not distribute snacks containing peanuts/tree nuts on their flight. However, Canadian, European, and Asian/Pacific passengers had significantly higher odds of requesting a peanut/tree nut–free meal from the airline. European and Asian/Pacific passengers had significantly lower odds of requesting a buffer zone. Having had a prior in-flight reaction was significantly associated with increased odds of performing several behaviors or making a request. Age and allergen-related trends for specific risk-mitigating behaviors are also displayed in Tables IV and V.

DISCUSSION

This is the fourth study to explore in-flight peanut and tree nut reactions, but the first to provide evidence that this is a global issue, detailing the experience of persons across 11 countries and 40 airlines. The 349 reported reactions make this the largest airline study to date, and this is the only study to specifically examine behaviors and actions that may be associated with decreased odds of having an in-flight reaction. This information is both novel and highly unique, and it represents measurable action that could be instituted into clinical practice to assist at-risk passengers when flying. We highlight 8 the following potentially risk-mitigating behaviors: (1) making any request of the airline, (2) requesting a buffer zone, (3) requesting an announcement that passengers not eat peanut/tree nut–containing goods, (4) requesting a peanut/tree nut–free meal, (5) wiping their tray table, (6) bringing their own food from home, and (7) avoiding use of an airline-provided pillow, and (8) avoiding use of an airline-provided blanket. We also highlight international differences in the extent to which these behaviors are exhibited.

Some findings were reassuring. Most travelers with allergy, both reactors and nonreactors, supply their own allergen-safe food, and nearly every respondent reported carrying their own epinephrine. In an aircraft it is extremely important for air travelers with food allergy to have their own source of epinephrine, so that they can respond rapidly at the first perceived sign of a reaction without having to wait for the crew to respond. Less reassuring is that, although the data indicate epinephrine is widely available, it appears it is not readily used as treatment. Only 13.3% of the reported reactions were treated with epinephrine, compared with 85.6% treated with antihistamine. This represents just a marginal increase in epinephrine use compared with what was found in a previous study.[9] Although a large number of passengers reported possessing their own epinephrine, until 100% always have a personal epinephrine source available when flying, there will be some unnecessary risk taking.

To better understand what might influence epinephrine use during an in-flight reaction, we explored the influence of organ-specific symptoms, requesting an accommodation, age, nationality, and airline policy toward peanut/tree nut. Reported cardiovascular symptoms/signs, gastrointestinal symptoms/signs, and notifying the crew of a reaction were significantly associated with higher odds of receiving epinephrine. Flying carriers with a "nut-free" policy was close to decreasing the odds of using epinephrine, interestingly, but did not quite achieve statistical significance. Nationality had no significant influence on use of epinephrine. What this trend represents is not clear; it may suggest the potential for an airline policy to create a false sense of security that the flight is "safe." Moreover, the fact that other reported symptoms, such as skin symptoms or wheezing, were not significantly associated with epinephrine use is troubling in light of several established criteria for diagnosing anaphylaxis and widespread educational efforts about when to administer epinephrine.[19,20] In-flight reactions are different than ground-based reactions, because there are fewer resources and poor access to emergency care should an initially undertreated reaction progress.[21-28] This point is especially important to consider, given that an exceptionally large proportion of reactors in this study reported developing respiratory symptoms. Increasing epinephrine use to treat a severe reaction is an area for immediate, continued global educational targeting and clinical practice improvement.[20]

Inconsistency has occurred in how the global air carriers address in-flight food allergy, and few carriers have an established policy in place to protect vulnerable persons.[17] Canada is the only country where a government agency has directly intervened, recently ordering Air Canada (but not other Canadian carriers) to establish a peanut/nut-free buffer zone, on specific request within

TABLE IV. Logistic regression model for factors associated with making a preflight requests among passengers that did and did not report an in-flight allergic reaction

Predictor	Any request	Buffer zone	Pre-board	Announcement to not eat items with PN/TN	Request PN/TN-free meal	Request PN/TN snacks not be distributed	Request to sit in certain seat/zone
Reported reaction	0.32 (0.19-0.54)*	0.64 (0.44-0.94)*	0.81 (0.55-1.19)	0.67 (0.46-0.96)*	0.43 (0.28-0.65)*	0.78 (0.56-1.08)	0.62 (0.36-1.08)
Nationality							
United States (reference)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Canada	0.89 (0.68-1.16)	1.08 (0.86-1.36)	0.62 (0.48-0.79)*	1.61 (1.28-20.2)*	1.93 (1.51-2.47)*	0.92 (0.74-1.15)	0.87 (0.63-1.2)
Europe	0.91 (0.61-1.34)	0.38 (0.25-0.59)*	0.17 (0.1-0.29)*	1.44 (1.03-2.03)*	5.76 (4.09-8.12)*	0.77 (0.56-1.08)	0.75 (0.44-1.28)
Asia/Pacific	0.9 (0.63-1.27)	0.4 (0.28-0.57)*	0.23 (0.16-0.33)*	0.42 (0.3-0.6)*	4.58 (3.4-6.17)*	0.6 (0.45-0.8)*	0.85 (0.56-1.29)
Other	3.36 (0.81-14)	1	1	0.29 (0.04-2.41)	1.2 (0.24-5.9)	0.3 (0.06-1.51)	1
Age							
Younger than 12 y (reference)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13-18 y	1.06 (0.77-1.47)	0.69 (0.52-0.92)*	0.5 (0.37-0.68)*	0.68 (0.52-0.9)*	0.91 (0.69-1.21)	1.28 (0.98-1.67)	0.52 (0.34-0.81)*
Older than 19 y	1.88 (1.38-2.55)*	0.38 (0.28-0.53)*	0.19 (0.12-0.28)*	0.38 (0.28-0.52)*	0.88 (0.65-1.18)	0.52 (0.39-0.68)*	0.46 (0.29-0.73)*
Male sex	0.96 (0.76-1.21)	0.94 (0.77-1.15)	1.04 (0.84-1.28)	1.03 (0.84-1.25)	0.99 (0.8-1.21)	1.05 (0.87-1.26)	0.87 (0.66-1.14)
Allergy							
Tree nut(reference)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Peanut	0.6 (0.41-0.84)*	1.4 (0.95-2.05)	0.86 (0.58-1.28)	1.84 (1.25-2.71)*	1.001 (0.7-1.43)	2.19 (1.56-3.09)*	1.11 (0.66-1.88)
Both	0.6 (0.44-0.84)*	1.58 (1.1-2.26)*	1.17 (0.81-1.69)	2.32 (1.62-3.34)*	1.07 (0.77-1.49)	2.44 (1.78-3.37)*	1.39 (0.85-2.26)
Valid doctor diagnosis	0.71 (0.43-1.16)	1.15 (0.69-1.94)	1.29 (0.71-2.34)	1.22 (0.75-2.01)	0.9 (0.56-1.44)	1.58 (0.99-2.5)	0.85 (0.44-1.65)
Prior in-flight reaction	0.32 (0.11-0.89)*	1.87 (1.09-3.22)*	1.66 (0.94-2.92)	1.83 (1.08-3.08)*	1.53 (0.83-2.8)	1.63 (1.001-2.64)	1.64 (0.76-3.54)

PN/TN, Peanut/tree nut.
Values are odds ratio (95% CI).
*Values represent $P < .05$.

TABLE V. Logistic regression model for factors associated with performing a protective in-flight behavior among passengers who did and did not report an in-flight allergic reaction

Predictor	Wipe tray table	Wipe seat belt	Wipe seat back	Wipe arm rest	Wipe common surfaces	Bring own food	Avoid using airline blanket	Avoid using airline pillow
Reported reaction	0.61 (0.44-0.86)*	0.85 (0.61-1.2)	0.8 (0.57-1.12)	0.73 (0.52-1.03)	0.76 (0.52-1.13)	0.19 (0.13-0.27)*	0.67 (0.48-0.94)*	0.67 (0.47-0.94)*
Nationality								
United States (reference)	1.00*	1.00	1.00	1.00	1.00	1.00	1.00*	1.00*
Canada	0.79 (0.62-1)*	0.66 (0.53-0.83)*	0.63 (0.5-0.78)*	0.7 (0.55-0.88)*	0.79 (0.61-1.01)	1.02 (0.73-1.43)	0.65 (0.52-0.81)*	0.68 (0.55-0.86)*
Europe	0.42 (0.3-0.59)*	0.3 (0.21-0.43)*	0.39 (0.28-0.56)*	0.33 (0.24-0.47)*	0.42 (0.27-0.65)*	0.71 (0.46-1.11)	0.17 (0.12-0.26)	0.2 (0.14-0.3)*
Asia/Pacific	0.61 (0.45-0.83)*	0.41 (0.31-0.55)*	0.41 (0.31-0.55)*	0.51 (0.38-0.69)*	0.33 (0.22-0.48)*	0.57 (0.38-0.85)*	0.17 (0.23-0.23)*	0.21 (0.15-0.29)*
Other	0.17 (0.03-0.89)*	0.10 (0.01-0.88)*	0.11 (0.01-0.89)*	0.08 (0.01-0.68)*	0.69 (0.14-3.46)	0.29 (0.06-1.29)	0.19 (0.04-0.93)*	0.19 (0.04-0.94)*
Age								
Younger than 12 y (reference)	1.00*	1.00*	1.00	1.00*	1.00	1.00	1.00*	1.00*
13-18 y	0.62 (0.47-0.81)*	0.55 (0.43-0.72)*	0.56 (0.43-0.73)*	0.64 (0.49-0.83)*	0.49 (0.35-0.68)*	0.79 (0.54-1.16)	0.65 (0.5-0.85)*	0.63 (0.48-0.82)*
Older than 19 y	0.26 (0.19-0.34)*	0.24 (0.18-0.32)*	0.23 (0.17-0.32)*	0.26 (0.19-0.34)*	0.41 (0.29-0.58)*	0.44 (0.31-0.62)*	0.46 (0.34-0.61)*	0.42 (0.32-0.56)*
Male sex	1.14 (0.93-1.4)	0.93 (0.77-1.13)	1.05 (0.86-1.27)	1.01 (0.82-1.23)	0.84 (0.67-1.04)	0.95 (0.72-1.25)	0.88 (0.72-1.07)	0.88 (0.72-1.07)
Allergy tree nut (reference)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Peanut	0.93 (0.66-1.31)	1.02 (0.72-1.43)	1.05 (0.75-1.48)	1.07 (0.76-1.5)	0.98 (0.65-1.48)	1.21 (0.78-1.88)	1.05 (0.74-1.48)	1.003 (0.71-1.41)
Both	1.28 (0.93-1.76)	1.39 (1.01-1.92)*	1.35 (0.98-1.85)	1.39 (1.02-1.91)*	1.45 (0.99-2.1)	1.55 (1.04-2.32)*	1.43 (1.04-1.98)*	1.34 (0.98-1.84)
Valid doctor diagnosis	1.73 (1.09-2.74)*	1.42 (0.88-2.3)	1.3 (0.81-2.1)	1.63 (1.02-2.61)*	1.04 (0.6-1.81)	1.65 (0.97-2.81)	1.43 (0.89-2.3)	1.35 (0.84-2.15)
Prior in-flight reaction	1.68 (1.004-2.79)*	1.67 (0.99-2.79)	1.78 (1.06-2.98)*	1.51 (0.91-2.52)	1.54 (0.88-2.69)	1.3 (0.78-2.14)	1.3 (0.73-2.3)	2.19 (1.31-3.64)*

Values are odds ratio (95% CI).
*Values represent $P < .05$.

48 hours of departure, to allow for medical review and approval of the case.[13] In the United States, legislation adopted in 1999 prevents government funding to assist carriers in making accommodations for a passenger with peanut allergy until a peer-reviewed, scientific study shows that circulating peanut allergen can be detected and causes harm to patients with allergy.[12,14] Such a study has yet to be conducted. What is more, the US Department of Transportation, as recently as 2011, indicated it would not involve itself in the peanut/airline issue. In our population, requesting a buffer zone was associated with lower odds of reporting a reaction; however, we strongly caution that this does not imply causality that buffer zones work but only that the request for a buffer zone was associated with lower odds of reaction. Interestingly, this particular request was not significantly associated with Canadian nationality, given the aforementioned policy for Air Canada.

This study is the first to explore behavioral differences among reactors and nonreactors that may influence the likelihood of reactivity, adjusted for nationality, allergen type, sex, and age. In lieu of a global airline or governmental policy to address this matter, the focus on influencing behavioral change at the passenger level is of key importance; this may be the most immediately modifiable and cost-efficient management strategy and would lessen the reliance on the airlines or government to take action.[14] Identification of these behaviors can also narrow the scope of what any potential future policy arguments may constitute. Moreover, these are 8 measures that a clinician can easily review with patients that may have significant clinical implications, in particular on passenger anxiety surrounding flying with a peanut allergy. However, further work is necessary to enhance the conceptual model of how to best protect travelers with peanut/tree nut allergy, validate the associations with the behaviors, and understand how unmeasured cultural aspects may influence the type of accommodation requested and likelihood of making a request.

Limitations of this study include the use of self-reported data, which is subject to recall bias, and questionable validity of the self-reported allergy, although methodologically no other feasible alternative was available to gather global information on in-flight reactions. Bias from selection may have occurred, given use of an Internet survey, use of any English-only survey, and from the predominance of participants from the United States and Canada. We are unsure of the effects of influence of membership or viewership in a food allergy advocacy group, as well. Furthermore, this study was observational, and no firm causal inference of definitive protection can be assumed from our findings. Finally, we do note a large proportion of persons who attributed reactions from inhalation, similar to the other studies on in-flight reactions.[7,9] Controversy remains about the plausibility of reactions from inhaled peanut/tree nut dust or peanut/tree nut–containing products.[10,11] We theorize that the inhalation reactions may be more attributable to unnoticed ingestion of dust that settled on a surface, leading to mucosal exposure after hand contact with a contaminated surface unbeknown to the respondent and were misattributed to inhalation, or simply resulted from anxiety. Nonetheless, it would be presumed that any reported allergic reaction occurring in an airplane cabin would be perceived as a valid medical emergency by the flight crew, despite academic controversy over route of exposure.

Flying with a peanut or tree nut allergy continues to be anxiety provoking for some. We present the largest in-flight peanut/tree nut study to date, the first to obtain international data on this topic, as well as explore the experience of those who have not reacted while flying with their allergy. Despite that 98% of passengers had a personal source of epinephrine available, epinephrine was underused to treat a reaction. This is discrepant with published recommendations, based on the reported symptoms in this population. Flight crews were not readily alerted to reactions when they occurred, but interestingly, when they were notified, it was associated with a higher odds that epinephrine was used to treat the reaction. This study highlights preliminary evidence that certain in-fight behaviors are associated with not having a reaction, highlights immediate strategies for at-risk passengers, and provides focus points for future hypothesis-confirming study. These findings may hold immediate value for the practicing clinician in advising his or her patients about flying with a peanut or tree nut allergy. Further efforts are needed to educate travelers with food allergy on how to best treat in-flight reactions and to continue to investigate strategies that may reduce the risk of an in-flight reaction, with a continued push for either formal governmental or airline policy to protect those at risk.

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